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A Synopsis of the Central Asian *Rhammatophyllum* (Brassicaceae)

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ABSTRACT. The genera *Koeiea* and *Prionotrichon* are reduced to the synonymy of *Rhammatophyllum*. The new combinations *R. afghanicum*, *R. erysimoides*, *R. flexuosum*, *R. gaudanense*, *R. ghoranum*, *R. kamelinii*, and *R. pseudoparrya* are proposed. A key to all nine species of the central Asian *Rhammatophyllum* is presented.

Key Words: Asia, Brassicaceae, *Koeiea*, *Mitophyllum*, *Prionotrichon*, *Rhammatophyllum*.

During work on the Brassicaceae for the forthcoming volume of Kubitzki's *Families and Genera of Vascular Plants*, it became evident that the limits of several genera need adjustment and that some nomenclatural changes are necessary. A case in point is the delimitation of the genera *Rhammatophyllum* O. E. Schulz, *Prionotrichon* Botschantsev & Vvedensky, and *Koeiea* K. H. Rechinger.

Schulz (1933a) proposed the genus *Mitophyllum* to accommodate a species previously placed in *Arabis* L., *A. pachyrhizum* Karelin & Kirilov, which is endemic to Kazakhstan. He (Schulz, 1933b) renamed the genus *Rhammatophyllum* because he discovered that his *Mitophyllum* is a later homonym to that of Greene (1904). *Mitophyllum* Greene is now recognized as a synonym of *Streptanthus* Nuttall (Al-Shehbaz, 1985; Rollins, 1993). *Rhammatophyllum* remained monotypic until Botschantsev (1952) and Vassiljeva (1969) each added another species.

Botschantsev and Vvedensky (1948) proposed the genus *Prionotrichon* and separated it from the closely related *Rhammatophyllum* by flower color, lack of the septum venation, and the type of indumentum. The flower color is said to be yellow in *Prionotrichon* and white in *Rhammatophyllum*, but the type species of the latter genus has creamy white to yellow flowers. The trichomes in both *R. pachyrhizum* and *R. frutex* are medifixed, sessile, and their two rays are rather soft and often crisped. Typically malpighiaceous trichomes, which are found in *Erysimum* L., *Lobularia* Desvaux, *Farsetia* Turra, and many other genera of Brassicaceae, are also medifixed and 2-rayed, but their rays are always rigid and straight. In the two original species that Botschantsev and Vvedensky (1948) assigned to *Prionotrichon*, *P. pseudoparrya* and *P. erysimoides*, the trichomes strongly resemble those of *Rhammatophyllum* in having soft, crisped rays, but their two rays have a few minute lateral branches. Finally, Botschantsev and Vvedensky (1948) indicated that the septum in *Rhammatophyllum* is 3-veined, while that of *Prionotrichon* is not veined. However, the septum in species of *Prionotrichon* has a broad central band sometimes marked by the presence of either a distinct midvein or three faint veins. Veined septa are rare in the Brassicaceae, and their occurrence in both *Rhammatophyllum* and *Prionotrichon* further supports the union of the two genera. Therefore, we believe that the differences in flower color, indumentum, and septum, which were claimed by Botschantsev and Vvedensky (1948) to support the recognition of two independent genera, are artificial and only one genus is represented.

Botschantsev (1966, 1987) expanded the limits

of *Prionotrichon* to include most of the species that Rechinger (1954, 1964, 1968) placed in *Koeiea*. It is interesting to note that Rechinger (1954) assigned *Koeiea* to the tribe Alysseae but later he (Rechinger, 1968) assigned it to the tribe Matthioleae. By contrast, Botschantsev (1966, 1987) placed the combined genus in the Arabideae, whereas Schulz (1936) placed *Rhammatophyllum* next to *Erysimum* in the tribe Hesperideae. The placement by these three authors of what we consider one genus in four tribes clearly shows the difficulties in the evaluation of generic and tribal relationships in the Brassicaceae based on few morphological characters. Without molecular studies on this complex, it is uncertain what the nearest relatives of *Rhammatophyllum* (including *Koeiea* and *Prionotrichon*) are. On the basis of habit, leaf and fruit morphology, and indumentum, it appears that *Rhammatophyllum* is perhaps more related to *Erysimum* than to any other genus.

Rechinger's (1968) account of *Koeiea* for *Flora Iranica* included a heterogeneous assemblage of species now assigned to different genera. For example, *K. altimurana* K. H. Rechinger was shown by Botschantsev (1987) to be a synonym of *Arabis fruticulosa* C. A. Meyer, a species also treated in that same flora (Hedge, 1968) in a different tribe, Arabideae. It is highly unlikely, however, that *A. fruticulosa* would eventually be retained in *Arabis* because the genus, as presently delimited, is clearly polyphyletic and needs to be divided into several segregates (Koch et al., 1999).

Polatschek and Rechinger (1968) retained *Erysimum gaudanense* Litvinov in *Erysimum* despite their observation that the trichomes are not typical of that genus because they have soft, crisped rays with minute lateral branches. On the basis of trichome morphology and other aspects of the plant, Botschantsev (1987) was correct in placing the species in *Prionotrichon* and in considering it to be closely related to the species we recognize herein as *Rhammatophyllum erysimoides*, *R. ghoranum*, *R. kamelinii*, and *R. pseudoparrya*.

Rechinger (1968) transferred *Parrya karatavica* Lipschitz to *Koeiea*, but because of its typically stellate, sessile, rigidly rayed trichomes and dentate, canescent, closely overlapping leaves, the species does not resemble any member of *Parrya* or *Rhammatophyllum* (including *Koeiea* and *Prionotrichon*). Nabiev (1972) placed the species in his monotypic genus *Botschantzevia* and indicated that it differs from *Arabis*, *Prionotrichon*, and *Rhammatophyllum* in having different trichomes. However, the placement of this species in a monotypic genus is inappropriate, and we believe that it shows more affinities to *Erysimum* than to any of the genera above.

As delimited herein, *Rhammatophyllum* includes nine species distributed from eastern Turkmenistan eastward through Afghanistan, northern Tajikistan, southern Kyrgyzstan, eastern Kazakhstan, and the Altay region of westernmost Mongolia. The genus has not yet been collected from western Xinjiang (China), but it is likely to be found at least in the western parts of Dzungaria. *Rhammatophyllum* consists of shrubs or subshrubs with linear to filiform, entire leaves that are attenuate into a persistent base, often slightly swollen nodes, minutely stalked, softly submalpighiaceous, or rarely subdendritic trichomes, yellow, creamy white, or rarely purple petals, latiseptate, torulose fruits, distinctly veined fruit valves, and flattened, winged, margined, or rarely wingless seeds. We consider the presence of incumbent cotyledons in the species originally placed in *Rhammatophyllum* and accumbent ones in those assigned to *Prionotrichon* to be a minor character insufficient to support the maintenance of two genera.

Rhammatophyllum O. E. Schulz, Repert. Sp. Nov. Regni Veg. 33: 190. 1933. Based on *Mitophyllum* O. E. Schulz, Notizbl. Bot. Gart. Berlin-Dahlem 11: 872. 1933, non Greene, Leafl. Bot. Observ. Crit. 1: 88. 1904. TYPE: *Rhammatophyllum pachyrhizum* (Karelin & Kirilov) O. E. Schulz.

Prionotrichon Botschantsev & Vvedensky, Bot. Mater. Gerb. Inst. Bot. Zool. Akad. Nauk Uzbekst. S.S.R. 12: 8. 1948. Syn. nov. TYPE: *Prionotrichon pseudoparrya* Botschantsev & Vvedensky.

Koeiea K. H. Rechinger, Anz. Österr. Akad. Wiss., Math.-Naturwiss. Kl. 91: 60. 1954. Syn. nov. TYPE: *Koeiea afghanica* K. H. Rechinger.

Plants subshrubs or shrubs. Trichomes unicellular, eglandular, softly malpighiaceous, submalpighiaceous with a few lateral minute branches, rarely subdendritic. Stems erect to ascending, branched, slightly swollen at nodes. Basal leaves absent. Cauline leaves sessile or rarely petiolate, filiform to linear or lanceolate, not auriculate, entire. Racemes several flowered, ebracteate, corymbose, elongated in fruit. Fruiting pedicels slender, ascending to divaricate. Sepals oblong, deciduous, ascending, subequal, base of lateral pair not saccate, margin membranous. Petals yellow, creamy white, or rarely purple, longer than sepals, distinctly clawed; blade obovate to spatulate, apex obtuse. Stamens 6, tetradynamous; filaments not dilated or slightly flattened at base; anthers oblong, apiculate at apex. Nectar glands confluent and subtending

bases of all stamens; median glands present or absent; lateral glands often annular. Ovules 16–40 per ovary. Fruit dehiscent siliques, linear, latiseptate, sessile or shortly stipitate; valves leathery, with a distinct midvein, hairy as leaves, torulose; replum rounded in cross section, visible; septum complete, membranous, veinless or with 1–3 longitudinal veins; style obsolete or distinct and to 2 mm long; stigma capitate, entire or 2-lobed. Seeds uniseriate, winged, margined, or wingless, oblong, strongly flattened; seed coat not mucilaginous when wetted; cotyledons accumbent or rarely incumbent.

1. **Rhammatophyllum pachyrhizum** (Karelin & Kirilov) O. E. Schulz, Repert. Sp. Nov. Regni Veg. 33: 190. 1933. *Arabis pachyrhiza* Karelin & Kirilov, Bull. Soc. Imp. Naturalistes Moscou 15: 144. 1842. *Mitophyllum pachyrhizum* (Karelin & Kirilov) O. E. Schulz, Notizbl. Bot. Gart. Berlin-Dahlem 11: 872. 1933. TYPE: [Kazakhstan. Dzungaria], Bischtas Mts., between Ayaguz and Donsyk, 1841, *G. S. Karelin & I. P. Kirilov 1193* (holotype, LE; isotypes, P, TK).

   Distribution. Kazakhstan, Kyrgyzstan.

   We have not seen the type collection of *Rhammatophyllum krascheninnikovii* A. N. Vassiljeva (Vassiljeva, 1969), and based on its similarity in flower color and other characters to *R. pachyrhizum*, we follow Czerepanov (1995) in reducing the former to synonymy of the latter.

2. **Rhammatophyllum frutex** Botschantsev & Vvedensky, Bot. Mater. Gerb. Inst. Bot. Akad. Nauk Uzbeksk. S.S.R. 13: 9. 1952. TYPE: [Kazakhstan]. W Betpak Dala, vicinity of Kenderlik, red clay slopes, 24 May 1936, *B. Mironov & V. Pazi 353* (holotype, TAK).

   Distribution. Endemic to Kazakhstan.

3. **Rhammatophyllum erysimoides** (Karelin & Kirilov) Al-Shehbaz & O. Appel, comb. nov. Basionym: *Arabis erysimoides* Karelin & Kirilov, Bull. Soc. Imp. Naturalistes Moscou 15: 145. 1842. *Prionotrichon erysimoides* (Karelin & Kirilov) Botschantsev & Vvedensky, Bot. Mater. Gerb. Inst. Bot. Zool. Akad. Nauk Uzbekst. S.S.R. 12: 8. 1948. TYPE: [Kazakhstan. Dzungaria], between Chulak and Ai rivers, 1841, *G. S. Karelin & I. P. Kirilov 1192* (holotype, LE; isotypes, B, P).

   Distribution. Endemic to Kazakhstan.

4. **Rhammatophyllum gaudanense** (Litvinov) Al-Shehbaz & O. Appel, comb. nov. Basionym: *Erysimum gaudanense* Litvinov, Trudy Bot. Muz. Imp. Akad. Nauk 1: 33. 1902. *Prionotrichon gaudanense* (Litvinov) Botschantsev, Novosti Sist. Vyssh. Rast. 3: 125. (1966). TYPE: [Turkmenistan]. "in declivibus herbosis montium prope Gaudan," 28 Apr. 1898, *D. I. Litvinov 518* (holotype, LE; isotype, WU).

   Distribution. Turkmenistan and Afghanistan.

5. **Rhammatophyllum ghoranum** (K. H. Rechinger) Al-Shehbaz & O. Appel, comb. nov. Basionym: *Koeiea ghorana* K. H. Rechinger, Anz. Österr. Akad. Wiss., Math.-Naturwiss. Kl. 101: 425. 1964. *Prionotrichon ghoranum* (K. H. Rechinger) Botschantsev, Novosti Sist. Vyssh. Rast. 24: 97 (1987). TYPE: Afghanistan. Prov. Ghorat: Shutar Khan Kotal ridge, between Qala Ahangaren and Qala Sharak, ca. 34°20′N, 64°55′E, ca. 2725 m, 27 July 1962, *K. H. Rechinger 18866* (holotype, W; isotype, MO).

   Distribution. Endemic to Afghanistan.

6. **Rhammatophyllum kamelinii** (Botschantsev) Al-Shehbaz & O. Appel, comb. nov. Basionym: *Prionotrichon kamelinii* Botschantsev, Novosti Sist. Vyssh. Rast. 24: 98. 1987. TYPE: Mongolia. Altay Mts., Uljastyjn-Gol, Bulgan-Gol, 10 July 1984, *R. V. Kamelin & S. Darijmaa 331* (holotype, LE; isotype, MO).

   Distribution. Endemic to the Altay region of Mongolia.

7. **Rhammatophyllum pseudoparrya** (Botschantsev & Vvedensky) Al-Shehbaz & O. Appel, comb. nov. Basionym: *Prionotrichon pseudoparrya* Botschantsev & Vvedensky, Bot. Mater. Gerb. Inst. Bot. Zool. Akad. Nauk Uzbekst. S.S.R. 12: 8. 1948. TYPE: [Tajikistan]. Alaisky Range, Karategen, near river Kizil-Su, above Sarigul, 10 Sep. 1927, *I. A. Raikova 1563* (holotype, TAK).

   Distribution. Northern Tajikistan and southern Kyrgyzstan.

8. **Rhammatophyllum flexuosum** (K. H. Rechinger) Al-Shehbaz & O. Appel, comb. nov. Basionym: *Koeiea flexuosa* K. H. Rechinger, Anz. Österr. Akad. Wiss., Math.-Naturwiss. Kl. 101: 426. 1964. *Prionotrichon flexuosum* (K. H. Rechinger) Botschantsev, Novosti Sist. Vyssh. Rast., 24: 99. 1987. TYPE: Afghanistan. Prov. Kabul: Sanglakht, above Jalrez, ca. 34°30′N, 68°32′E, ca. 2400 m, 12 July 1962, *K. H. Rechinger 18027* (holotype, W).

Distribution. Endemic to Afghanistan.

9. Rhammatophyllum afghanicum (K. H. Rechinger) Al-Shehbaz & O. Appel, comb. nov. Basionym: *Koeiea afghanica* K. H. Rechinger, Anz. Österr. Akad. Wiss., Math.-Naturwiss. Kl. 91: 60. 1954. *Prionotrichon afghanicum* (K. H. Rechinger) Botschantsev, Novosti Sist. Vyssh. Rast. 3: 125. 1966. TYPE: Afghanistan. Bend-i Amir, 2800 m, 19 Aug. 1948, *M. Köie 2845* (holotype, C; isotype, W).

Distribution. Endemic to Afghanistan.

KEY TO THE SPECIES OF *RHAMMATOPHYLLUM*

1a. Trichomes subdendritic, rarely mixed with fewer submalpighiaceous ones; fruits (2.5–)3–4.5 mm wide; seeds broadly winged all around; Afghanistan . . . . . 9. *R. afghanicum*

1b. Trichomes malpighiaceous or submalpighiaceous; fruits 1–2(–2.5) mm wide; seeds wingless, margined, or narrowly winged all around, rarely broadly winged distally.

2a. Trichomes exclusively malpighiaceous with unbranched 2 rays; cotyledons incumbent; seeds wingless, rarely obscurely margined.

3a. Petals purple; shrubs ca. 50 cm tall; leaves 0.5–2.5 cm × 0.9–1.2 mm; Kazakhstan . . . . . 2. *R. frutex*

3b. Petals creamy white; plants subshrubs 10–30 cm tall; leaves (2.5–)3–7 cm × ca. 0.5 mm; Kazakhstan and Kyrgyzstan . . . . . 1. *R. pachyrhizum*

2b. Trichomes submalpighiaceous, with minute lateral branches on the 2 rays; cotyledons accumbent; seeds winged, rarely margined.

4a. Leaves with a distinct petiole 0.5–2 cm long; fruits 5–8 cm long; replum straight between the seeds in mature fruit.

5a. Petals 10–13 × 5–7 mm; leaves 2–7 mm wide; petiole 1–2 cm long; Altay of Mongolia . . . 6. *R. kamelinii*

5b. Petals 7–8 × 3–4 mm; leaves to 1 mm wide; petiole rarely to 1 cm long; Kazakhstan . . 3. *R. erysimoides*

4b. Leaves sessile; fruits 1.5–4(–5) cm long; replum often constricted between the seeds in mature fruit.

6a. Gynophore 1–3 mm long; racemes flexuous in fruit; sterile shoots often well developed, with leaves to 2–3 cm long; Afghanistan 8. *R. flexuosum*

6b. Gynophore obsolete, rarely to 0.7 mm long; racemes not flexuous in fruit; sterile shoots absent, if present then with leaves rarely to 1.5 cm long.

7a. Leaves flat; seeds distinctly winged all around; Afghanistan . . . . . 5. *R. ghoranum*

7b. Leaves longitudinally plicate; seeds narrowly margined at least distally.

8a. Petals pilose outside; gynophore obsolete; style to 1 mm; Afghanistan and Turkmenistan . . . . . 4. *R. gaudanense*

8b. Petals glabrous outside; gynophore distinct, to 0.7 mm; style 1–2 mm; Tajikistan and Kyrgyzstan . . . . . 7. *R. pseudoparrya*

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